when it swerved, and came towards the ground in a different direction, alighting as though it were in possession of its natural powers, some hundreds of yards from the place whence it rose. On going to the spot where it had settled, it was found to be alive and crouching in the long grass. The keeper ran in and placed his hand on it, when the bird struggled and tried to get away; he killed it seeing that it was wounded. On examining the bird immediately after I found that it had been struck by two pellets of No. 6 shot, one of which had penetrated the pectoral muscles, but had not injured the cavity; the lungs and other viscera were uninjured. The other pellet had entered behind and below the left eyeball, and, passing forward, had emerged on the other side, passing above the upper mandible. The brain was uninjured, but the lower part of the left eyeball was cut and distended with blood. There was no other injury. No doubt the shock had confused the bird, and caused its strange flight, which, though upward, was very different in its character from that of ordinary towering where the lungs are perforated, and unconsciousness is the result of the circulation of non-aërated blood.

J. FAYRER

Meteors

PERMIT me to point out to Mr. J. M. Hayward (NATURE, Nov. 8, p. 30) that his observation of the large meteor of November 4 possesses no scientific value, inasmuch as he has omitted to mention the important features of its appearance. The time is given as "just now" (or November 4), and the broad path of fire which this fine meteor discharged upon its course must have been situated *somewhere* in the south-east, for your correspondent states he saw it "on turning to the south-east."

I had endeavoured to show in NATURE of the preceding week (Nov. 1, p. 6) that these delightfully vague forms of expression as applied to meteors are wholly inadequate, and, as such, cannot receive any attention at the hands of those who investigate these phenomena.

Had Mr. Hayward given us the essential details of his observation, it might have proved very valuable, for a large meteor (perhaps identical with the one he refers to) was observed at many places on the night of November 4. As recorded at Chelmsford, Bath, and Bristol the paths were:—

Time.		Mag.	From α	From δ	To α	To δ	Observer.
1883.	h. m.		°	°			
Nov. 4	10 14	= ♀	8	S. 20	355	S. 30	H. Corder, Chelmsford.
Nov. 4	10 12	6 × ♃	33	S. 6	9	S. 23	J. L. Stothert, Bath.
Nov. 4	10 12	> ♃	36	N. 1½	16	S. 19	W. F. Denning, Bristol.

The several estimates of brilliancy are very discordant, but the time and paths agree so closely that there is little doubt the observations refer to the same meteor.

Another fine meteor was seen here on October 26 at 9h. 17m. It gave a succession of four lightning-like flashes. Path from α 288 δ 56° + to α 333° δ 59° +. This was not the only fireball visible that night, for I see by NATURE (November 8, p. 44) that "On October 26 at about 7 p.m. a splendid meteor was seen in the district of Hernösand, Sweden." It appeared "with a blinding white lustre in the zenith and travelling very rapidly down to the horizon." In this case again we have to deplore the extremely vague manner of the description. Had the precise direction of flight been given, it would have been interesting to determine whether this fireball belonged to the same stream as the equally fine one recorded at Bristol on the same night.

W. F. DENNING

Bristol, November 10

THE meteors during October have been numerous, and the most of them proceeded from some point in Auriga. With the exception of about nine days of unfavourable weather, I have seen several meteors night and morning throughout October, but they were generally small and transient. I have counted fifty-two from 10 p.m. of October 3 to 4·30 a.m. of the 4th, many of them large and of several seconds' duration. The largest of these passed slowly from the first bright star on the left of Capella, in Auriga, to a point about 1° below α Cygni. The smallest of them blinked rapidly before the eye in the zenith over the Milky Way, which, this night, was the principal theatre of their display. From 3.30 to 4.30 a.m. I counted forty of the fifty-two meteors. From 1 a.m. to 4 of October 8 I observed very brilliant meteors. One at 2.25 a.m. darted from about 1° above Capella and disappeared at a point ½° from Phad in the Plough, without exploding and without leaving any trace of light behind. It was as large as Venus. At 2.40 a.m. a very large and brilliant meteor dashed out from a point midway between Capella and the first bright star to its right in Auriga, and sped along above the Pleiades and Aries through the Square of Pegasus, and exploded 3° beyond it, leaving no fire in its wake. October 15, 11.38 p.m., a very unusual meteor sailed slowly from β Ceti to within 1° of Betelgueux, in the right shoulder of Orion. After travelling two-thirds of its journey, it exploded into four, three of which formed the head of an arrow, and the fourth adorned its tail, all the four sending out bright nebulous light behind them. At 2.50 a.m., October 26, a large ball of fire (bolide), apparently seven inches in diameter, illumined the heavens with great brilliancy as it descended from about midway between the third and fourth bright stars on the left of Capella, exploding twice during the last half of its journey, and disappearing just as it reached the moon. It had no tail. It was seen by some of the Paisley night police, and one of them was frightened that it would dash the moon out of the heavens. This bolide had no detonation in either of its two explosions, and the last of it was only about the size of Jupiter. One policeman describes it as a large fiery ball of the size of the full moon, but this is an exaggeration. The extraordinary meteor of October 15, after its explosion, was described by an observer as a well-formed arrow of flaming fire, followed by a ball of fire with a tail. To me it appeared to resemble the head and body of a fish, as well as the form of an arrow.

DONALD CAMERON

Mossvale, Paisley, November 6

ON the evening of Saturday last, at 10.12 p.m., a remarkable meteorite was observed close to Trinity College, Glenalmond, in Perthshire. It presented the appearance of a bright spherical ball, which moved horizontally from east-north-east to west-south-west at a height roughly estimated at 300 feet. When it began to curve downwards it disappeared from view, but it left behind it a luminous trail of great brilliancy, which was seen for fully forty seconds, its brilliancy gradually diminishing till it entirely faded away.

W. BESANT LOWE

Trinity College, Glenalmond, Perth, November 12

"Anatomy for Artists"

I AM quite unable to do as your correspondent "An Art Student" suggests, for the second edition of the above-named book has been just issued. I may add, however, that the reasons which led me deliberately to adopt the plan alluded to in regard to the illustrations of the bones still remain, in my opinion, sound, and I trust that the majority of my readers of the past, present, and future editions have not been and will not be "discouraged" by the effort which I desire them, for their own sakes as students, to make.

JOHN MARSHALL

10, Savile Row, W., November 12

P.S.—It seems that *I* ought to have two "letters of reference" attached to myself, for I am not "Dr." but "Mr." Marshall.

Earthquake

NATURE on October 25 contained notices of shocks of earthquake which were felt at a quarter to one o'clock on the night of October 19 (11h. 20m. Greenwich M.T.) at Cadiz and other places on the coast of Andalusia. I have information that about 17h. 45m. later these shocks, which were travelling from east to west, had apparently reached Bermudas. In a letter just received from ex-Chief Justice Darrell, dated October 22, he remarks:—"A very unusual event occurred here on the 20th of this month, in a shock of an earthquake, which however was slight; no life was lost, nor serious damage done to buildings; but the shock, which lasted less than a minute, at about a quarter past one p.m. was universally and unmistakably felt throughout the colony. It is said to be only the third time that any earthquake has been experienced in Bermuda in the last forty years." A quarter past one in Bermuda would be about four and a half minutes past five at Greenwich, requiring, if the shocks originated in the same wave, a rate of transmission of about 158 geographi-

cal miles an hour, or 2·6 miles per minute; less than half the rate at which the great shocks of 1755 and 1761 crossed the Atlantic from Lisbon to Barbados, which is given by Mallet as 7·3 miles, or 6·3 geographical miles per minute.[1]

J. H. LEFROY

"Partials"

IN your number of Nov. 1, p. 6, I noticed an article the object of which was to account for the existence of "partials." Were the theory therein set forth correct, we should have a constant number of "partials" for any given "fundamental" tone of constant force regardless of its source; whereas it is a well-known fact that, while the tones of some instruments are rich in "partials," those of other instruments have but few.

CROMWELL O. VARLEY

Cromwell House, Bexley Heath, Kent

SCIENCE AND ENGINEERING

IN the address delivered by Mr. Westmacott, President of the Institution of Mechanical Engineers, to the English and Belgian engineers assembled at Liége last August, there occurred the following passage:—"Engineering brings all other sciences into play: chemical or physical discoveries, such as those of Faraday, would be of little practical use if engineers were not ready with mechanical appliances to carry them out, and make them commercially successful in the way best suited to each."

We have no objection to make to these words, spoken at such a time and before such an assembly. It would of course be easy to take the converse view, and observe that engineering would have made little progress in modern times, but for the splendid resources which the discoveries of pure science have placed at her disposal, and which she has only had to adopt and utilise for her own purposes. But there is no need to quarrel over two opposite modes of stating the same fact. There *is* need on the other hand that the fact itself should be fairly recognised and accepted, namely, that science may be looked upon as at once the handmaid and the guide of art, art as at once the pupil and the supporter of science. In the present article we propose to give a few illustrations which will bring out and emphasise this truth.

We could scarcely find a better instance than is furnished to our hand in the sentence we have chosen for a text. No man ever worked with a more single-hearted devotion to pure science—with a more absolute disregard of money or fame, as compared with knowledge—than Michael Faraday. Yet future ages will perhaps judge that no stronger impulse was ever given to the progress of industrial art, or to the advancement of the material interests of mankind, than the impulse which sprang from his discoveries in electricity and magnetism. Of these discoveries we are only now beginning to reap the benefit. But we have merely to consider the position which the dynamo-electric machine already occupies in the industrial world, and the far higher position which, as almost all admit, it is destined to occupy in the future, in order to see how much we owe to Faraday's establishment of the connection between magnetism and electricity. That is one side of the question—the debt which art owes to science. But let us look at the other side also. Does science owe nothing to art? Will any one say that we should know as much as we do concerning the theory of the dynamo-electric motor, and the laws of electro-magnetic action generally, if that motor had never risen (or fallen, as you choose to put it) to be something besides the instrument of a laboratory, or the toy of a lecture-room. Only a short time since the illustrious French physicist, M. Tresca, was enumerating the various sources of loss in the transmission of power by electricity along a fixed wire, as elucidated in the careful and elaborate experiments inaugurated by M. Marcel Deprez, and subsequently continued by himself. These losses—the electrical no less than the mechanical losses—are being thoroughly and minutely examined in the hope of reducing them to the lowest limit; and this examination cannot fail to throw much light on the exact distribution of the energy imparted to a dynamo machine, and the laws by which this distribution is governed. But would this examination ever have taken place—would the costly experiments which render it feasible ever have been performed—if the dynamo machine was still under the undisputed control of pure science, and had not become subject to the sway of the capitalist and the engineer?

Of course the electric telegraph affords an earlier and perhaps as good an illustration of the same fact. The discovery that electricity would pass along a wire and actuate a needle at the other end was at first a purely scientific one; and it was only gradually that its importance, from an industrial point of view, came to be recognised. Here again art owes to pure science the creation of a complete and important branch of engineering, whose works are spread like a net over the whole face of the globe. On the other hand, our knowledge of electricity, and specially of the electro-chemical processes which go on in the working of batteries, has been enormously improved in consequence of the use of such batteries for the purposes of telegraphy.

Let us turn to another example in a different branch of science. Whichever of our modern discoveries we may consider to be the most startling and important, there can I think be no doubt that the most beautiful is that of the spectroscope. It has enabled us to do that which but a few years before its introduction was taken for the very type of the impossible, viz. to study the chemical composition of the stars; and it is giving us clearer and clearer insight every day into the condition of the great luminary which forms the centre of our system. Still, however beautiful and interesting such results may be, it might well be thought that they could never have any practical application, and that the spectroscope at least would remain an instrument of science, but of science alone. This however is not the case. Some thirty years since Mr. Bessemer conceived the idea that the injurious constituents of raw iron—such as silicon, sulphur, &c.—might be got rid of by simple oxidation. The mass of crude metal was heated to a very high temperature; atmospheric air was forced through it at a considerable pressure; and the oxygen uniting with these metalloids carried them off in the form of acid gases. The very act of union generated a vast quantity of heat, which itself assisted the continuance of the process; and the gas therefore passed off in a highly luminous condition. But the important point was to know where to stop; to seize the exact moment when all or practically all hurtful ingredients had been removed, and before the oxygen had turned from them to attack the iron itself. How was this point to be ascertained? It was soon suggested that each of these gases in its incandescent state would show its own peculiar spectrum; and that, if the flame rushing out of the throat of the converter were viewed through a spectroscope, the moment when any substance such as sulphur had disappeared would be known by the disappearance of the corresponding lines in the spectrum. The anticipation, it is needless to say, was verified; and the spectroscope, though now superseded, had for a time its place among the regular appliances necessary for the carrying on of the Bessemer process.

This process itself, with all the momentous consequences, mechanical, commercial, and economical, which it has entailed, might be brought forward as a witness on our side; for it was almost completely worked out in the laboratory before being submitted to actual practice. In this respect it stands in marked contrast to the earlier processes for the making of iron and steel, which

[1] Mallet's Fourth Report, British Association, 1858.